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EXPERIMENTAL DESIGN AND ANALYSIS OF DOMESTIC WINDMILL BLADES

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ABSTRACT

Presently, India is stepping towards becoming a global super power. This research implies that it is leading the list of developing countries in terms of economic development. Therefore, the energy requirement of the country would increase in rapid rate. In this research paper, the optimum twist of a windmill blade is examined on the basis of elementary blade-element theory. From this project to find out the wind speed and blade angular velocity depends upon the variation of the sectional lift and drag coefficients with angle of attack. This results show optimum angle of attack decreases from the maximum-lift-coefficient angle of attack at the blade root to greater than 80% of this value at the blade tip

KEYWORDS: Windmill Blade, Drag Coefficients & Angle of Attack

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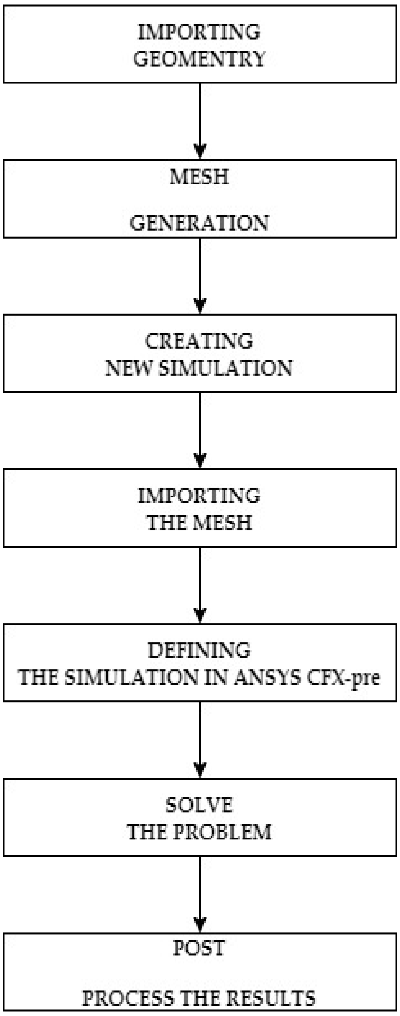
Original Article

INTRODUCTION

A windmill is a machine which converts the energy of wind to rotational motion by means of adjustable vanes called sails. The main use is for a grinding mill powered by the wind, reducing a solid or coarse substance into pulp or minute grains, by crushing, grinding, or pressing. Windmills have also provided energy to sawmills, paper mills, hammer mills, and wind pumps for obtaining fresh water from underground or for drainage (especially of land below sea level).

Unlike the old-fashioned Dutch windmill design, this relied mostly on the wind's force to push the blades into motion; modern turbines use more sophisticated aerodynamic principles to capture the wind's energy most effectively. The two primary aerodynamic forces at work in wind-turbine rotors are lift, which acts perpendicular to the direction of wind flow; and drag, which acts parallel to the direction of wind flow.

MODELLING AND ANALYSIS PROCEDURE



Step I – Importing Geomentry

- Open the ANSYS workbench in click the icon on the desktop. File > new > geometry> File import external geometry file> Select the IGES (International Graphic Exchange System) file of the windmill blade is created in CATIA software > generate > ok
- Create the enclosure by click the tools > enclosure > give the value of 500mm> generate > ok.
- Create the Boolean operation; this operation is used to separate the space of the windmill blade in the enclosure.

Step II – Mesh Generation

Create the 2d Regions

To create the composite 2D region for Inlet, outlet and wall on the enclosure.

SETTING UP THE MESH

Set the Maximum Spacing

In the details view, the change Maximum Spacing is set to 50mm. In default face, spacing in the Tree View, which is contained in mesh. In the Details View, change Maximum Spacing to 50mm.

Generating the Volume Mesh

To generate the Volume Mesh in the tree.

Step III- Creating New Simulation

To create the file name and save simulation as windmill analysis.

Step IV – Importing the Mesh

To select or create the Import Mesh.

Step V – Defining the Simulation in ANSYS CFX-pre Processor

Setting the Simulation Type

Table 1

Tab	Setting	Value
BASIC SETTINGS	Simulation type	Transient
	Total time	20 sec
	Time steps	20
	Initial time	0 sec

SETTING BOUNDARY CONDITIONS

Inlet Boundary

To create a new boundary condition named INLET.

OUTLET BOUNDARY

To create a new boundary condition named OUTLET.

Wall Boundary

To create boundary condition named Wall.

Setting Initial Values

To set the initial values and global *Initialization.*

Table 2

Tab	Setting	Value
Global Settings	Initial Conditions > Velocity Type	Cartesian
	Initial Conditions > Cartesian Velocity Components > Option	Automatic with Value
	Initial Conditions > Cartesian Velocity Components > U	-10 [m s^-1]
	Initial Conditions > Cartesian Velocity Components > V	0.2 [m s^-1]
	Initial Conditions > Cartesian Velocity Components > W	0.2 [m s^-1]
	Initial Conditions > Static Pressure > Relative Pressure	1 Pa]
	Initial Conditions > Temperature > Temperature	25 [C]
	Initial Conditions > Turbulence Kinetic Energy > Fractional Intensity	(Selected)
	Initial Conditions > Turbulence Eddy Dissipation	(Selected)
	Initial Conditions > Turbulence Eddy Dissipation > Eddy Length Scale	(Selected)
	Initial Conditions > Turbulence Eddy Dissipation > Eddy Length Scale > Eddy Len. Scale	0.25 [m]
	Initial Conditions > Radiation Intensity > Blackbody Temperature	(Selected)
	Initial Conditions > Radiation Intensity > Blackbody Temperature > Blackbody Temp.	25 [C]

STEP VI – SOLVE THE PROBLEM

Setting Solver Control

Table 3

Tab	Setting	Value
Basic Settings	Transient Scheme > Option	Second Order Backward Euler
	Convergence Control > Max. Coeff. Loops	3

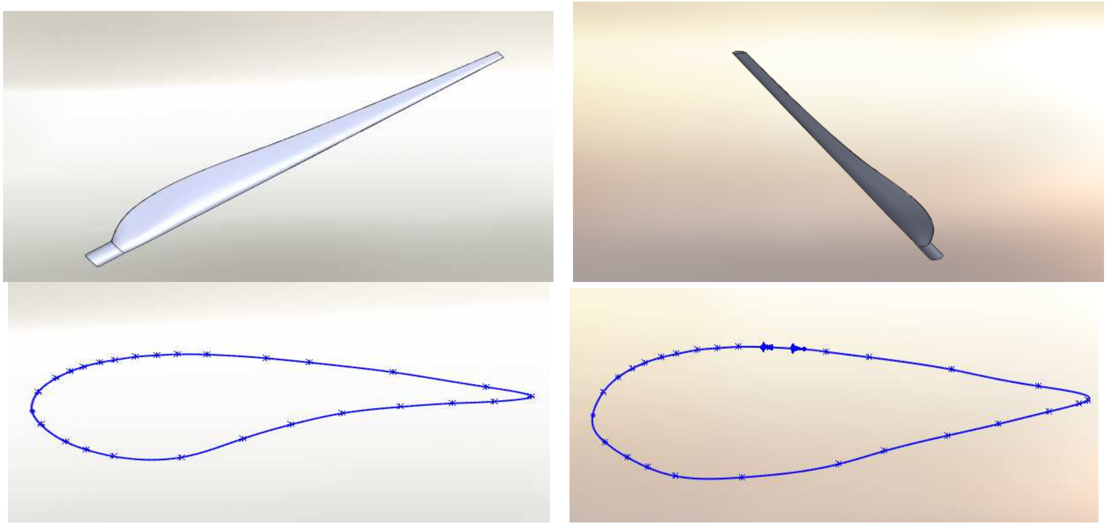
Setting Output Control

Table 4

Setting	Value
Option	Selected Variables
Output Variables List	Pressure, Radiation Intensity, Temperature, Velocity
Output Variables Operators	(Selected)
Output Variables Operators > Output Var. Operators	All*
Output Frequency > Option	Time Interval
Output Frequency > Time Interval	Every timestep

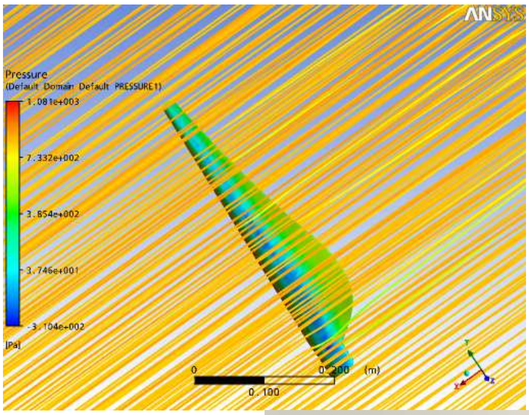
STEP VII-POST PROCESS THE RESULTS

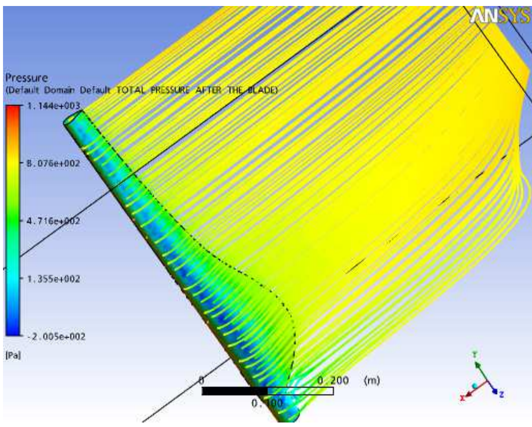
In these sections, we get all required results and save the results as image files and video files.

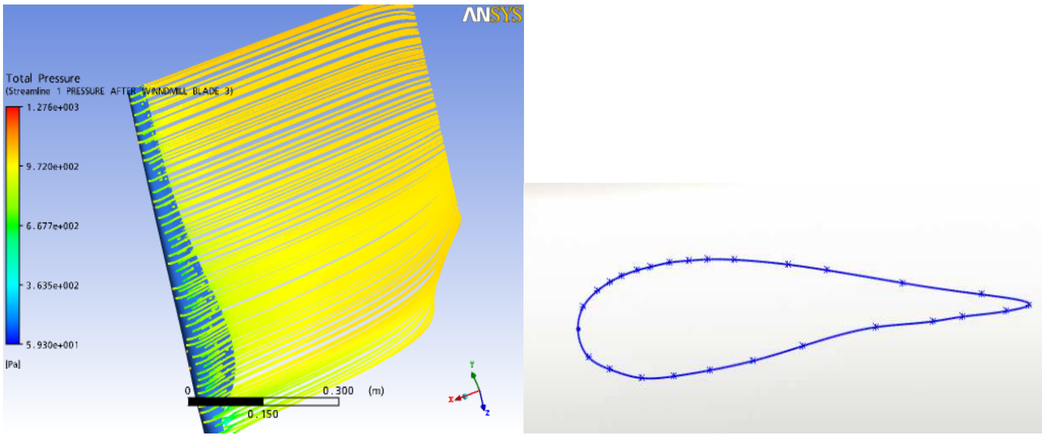


Blade Design-1 & Airflow Images **Blade Design-2& Airflow Images**

Figure 1







Blade Design-3

Figure 2

CONCLUSIONS

This paper conclude that the wind turbine models with respect to different objectives as more production energy, safety of turbine, so that the wind turbine dimensions are increased and the control methods are required to respond quickly and effectively to the important task of the power generation. Thus, the project is carried out in 3D design method and analyzed the design.

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